PATENT ABSTRACTS OF JAPAN

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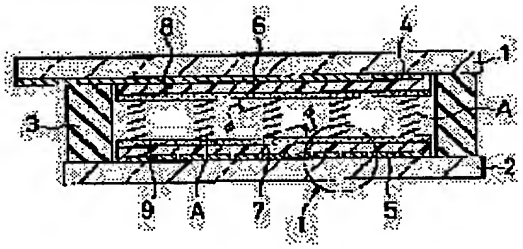
(54) LIQUID CRYSTAL DISPLAY ELEMENT

(57)Abstract:

PURPOSE: To provide a liquid crystal display element capable of obtaining good display quality free from the initial orientation defect of a liquid crystal and reverse tilt discrimination, etc., at the time of applying a driving voltage by forming horizontally oriented films as rough surfaces films having microruggedness and horizontally orienting liquid crystal molecules with the pretilt angle corresponding to the surface roughness of the oriented films.

CONSTITUTION: The horizontally oriented films 8, 9 formed by the LB method (Langmuir-Blodgett technique) on both substrates 1, 2 are formed as the rough surfaces films having the microruggedness and the liquid crystal molecules A are horizontally oriented at the pretilt angle ϕ corresponding to the surface roughness of the oriented films 8, 9. The horizontally oriented films 8, 9 are formed as the rough surface films by roughening the film surfaces of insulating films 6, 7 formed to cover transparent electrodes 4, 5 on the ground surfaces, i.e., both substrates 1, 2 on which the oriented films are formed. Then, the liquid crystal molecuels are oriented with the desired pretilt angle if the surface roughness of the oriented films 8, 9 is controlled. The display quality free from the initial orientation defect of the liquid crystal and the reverse tilt discrimination, etc., at the time of applying the driving voltage is obtd.



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CLAIMS

[Claim(s)]
[Claim 1] To the field which counters mutually [the transparence substrate of the pair which counters on both sides of a liquid crystal layer], a transparent electrode, It is the liquid crystal display component in which the level orientation film which consists of polyimide film which carried out the laminating of the monomolecular film of the amphiphilic compound which has a hydrophobic radical and a hydrophilic radical by the Langmuir-Blodgett's technique, and imide-ization-processed this cascade screen was formed. The liquid crystal display component characterized by having used said level orientation film as the split-face film with minute irregularity, and carrying out level orientation of the liquid crystal molecule with the pre tilt angle according to the surface roughness of said orientation film.
[Claim 2] Said level orientation film is a liquid crystal display component according to claim 1 characterized by considering as the split-face film by making into a split face the substrate side which forms this orientation film.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the liquid crystal display component to which orientation of the liquid crystal molecule was carried out horizontally.
[0002]
[Description of the Prior Art] There are some which used the thing in TN (Twisted Nematic) mode, the thing in STN (super twisted nematic) mode, the thing of the level orientation mold of the ECB (electric-field control mold birefringence) modes, a ferroelectric liquid crystal, or antiferroelectricity liquid crystal in the liquid crystal display component to which orientation of the liquid crystal molecule was carried out horizontally.
[0003] These liquid crystal display components have the composition in which a transparent electrode and the level orientation film for carrying out orientation of the liquid crystal molecule horizontally were formed to the field which counters mutually [the transparence substrate of the pair which counters on both sides of a liquid crystal layer].
[0004] although the level orientation film prepared on the substrate of these liquid crystal devices was conventionally formed by the approach of applying polyimide etc. on a substrate and carrying out rubbing processing of the film surface, or the approach of carrying out the method vacuum evaporationo of the oxidation silicon (Si O2) etc. of slanting on a substrate -- recently -- Langmuir BUROJIETTO (Langumuir-Blodgett) -- the approach of forming the level orientation film which consists of polyimide film by law is adopted increasingly.
[0005] The above-mentioned Langmuir-Blodgett's technique (it is hereafter described as the LB method) is the approach of making a monomolecular film on a potentiometric surface, and making put the monomolecular film on the water surface on a substrate, pulling up the substrate made beforehand immersed at right angles to underwater with constant speed, and going.
[0006] this LB -- the monomolecular film of the amphiphilic compound with which formation of the polyimide film by law has a hydrophobic radical and a hydrophilic radical, for example, the polyamic-acid derivative compound which comes to carry out the ionic-bond reaction of polyamic acid and the amine which has a long-chain alkyl group, -- LB -- it is carried out by the approach of carrying out the multiple-times loop of the process made to put on a substrate by law, and carrying out the laminating of said monomolecular film on a substrate, and imide--ization-processing this cascade screen and using as the polyimide film.
[0007] Above LB -- the stacking tendency the polyimide film with which the monomolecular film of the amphiphilic compound put by law on the substrate imide-ized the cascade screen of this monomolecular film since the long molecule of molecule length was located in a line along the pull-up direction of a substrate makes [stacking tendency] an one direction carry out [stacking tendency] orientation of the liquid crystal molecule to homogeneity -- **** -- this polyimide film can be used as the level orientation film as it is, without getting down, therefore carrying out rubbing processing of that film surface.
[0008] By the way, in a liquid crystal display component, since the orientation condition of a liquid

crystal molecule influences greatly the electro-optics property of a liquid crystal display component, in order to obtain a good display, it is necessary to improve stability of the orientation of a liquid crystal molecule.

[0009] The important element which influences the stability of the orientation of this liquid crystal molecule is the pre tilt angle (include angle which the major axis of a liquid crystal molecule makes to a substrate side) of the liquid crystal molecule to the substrate side under the condition of not impressing an electrical potential difference, and the stability of the orientation of a liquid crystal molecule becomes good, so that this pre tilt angle is large.

[0010]

[Problem(s) to be Solved by the Invention] However, although the one direction could be made to carry out orientation of the liquid crystal molecule to homogeneity when based on the level orientation film formed by the describing [above] LB method, it was difficult to give a desired pre tilt angle to a liquid crystal molecule.

[0011] for this reason, the level orientation film — Above LB — the problem of the conventional liquid crystal display component currently formed by law producing the poor initial orientation of liquid crystal, or generating a reverse tilt discreenation at the time of driver voltage impression — **** — it was.

[0012] Forming the level orientation film by the LB method, this invention gives and carries out orientation of the pre tilt angle of a request of a liquid crystal molecule, and aims at offering the liquid crystal display component which can acquire good display quality without the poor initial orientation of liquid crystal, the reverse tilt discreenation at the time of driver voltage impression, etc.

[0013]

[Means for Solving the Problem] The liquid crystal display component of this invention to the field which counters mutually [the transparence substrate of the pair which counters on both sides of a liquid crystal layer] A transparent electrode, The level orientation film which consists of polyimide film which carried out the laminating of the monomolecular film of the amphiphilic compound which has a hydrophobic radical and a hydrophilic radical by the LB method, and imide-ization-processed this cascade screen is formed. It is characterized by having used said level orientation film as the split-face film with minute irregularity, and carrying out level orientation of the liquid crystal molecule with the pre tilt angle according to the surface roughness of said orientation film. In the one embodiment of this invention, it is considering as the split-face film by making into a split face the substrate side which forms this orientation film for said level orientation film.

[0014]

[Function] Thus, if the level orientation film is used as the split-face film with minute irregularity and the surface roughness of this orientation film will be controlled in order that a liquid crystal molecule may carry out level orientation with the pre tilt angle according to the surface roughness of the orientation film, orientation of the pre tilt angle of a request of a liquid crystal molecule can be given and carried out, and good display quality without the poor initial orientation of liquid crystal, the reverse tilt discreenation at the time of driver voltage impression, etc. can be acquired.

[0015]

[Example] Hereafter, the example of this invention is explained with reference to a drawing.

[0016] Drawing 2 is the sectional view of a liquid crystal display component. This liquid crystal display component joins the transparence substrates 1 and 2 of a pair which consist of glass etc. through the frame-like sealant 3, it is what enclosed liquid crystal with both this substrate 1 and the field surrounded by the sealant 3 between two, and the transparent electrodes 4 and 5 which consist of transparence electric conduction film, such as ITO, are formed in the field where both the substrates 1 and 2 counter mutually, respectively. Moreover, the electrode forming face of both these substrates 1 and 2 is covered by the transparent insulator layers 6 and 7 which consist of oxidation silicon (Si O2) etc., and the level orientation film 8 and 9 is formed on these insulator layers 6 and 7.

[0017] In addition, this liquid crystal display component is the thing in TN mode or STN mode, and both the substrates 1 and the molecule A of the liquid crystal enclosed among two are regulated by said

orientation film 8 and 9, and are carrying out twist orientation of each orientation direction of the liquid crystal molecule A near both the substrates 1 and the orientation film 8 and 9 by the side of two on the predetermined twist square between both the substrates 1 and 2. However, at drawing 2 , the liquid crystal molecule A is shown in the condition of having not carried out twist orientation, for convenience.

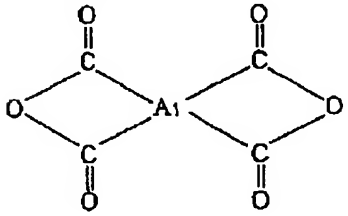
[0018] The above-mentioned level orientation film 8 and 9 consists of polyimide film which imide-ized the film which made each put in piles the monomolecular film of the amphiphilic compound which has a hydrophobic radical and a hydrophilic radical, for example, the compound to which polyamic acid and the amine (henceforth long-chain alkylamine) which has a long-chain alkyl group are made to come to react, on several layers - dozens of layers.

[0019] These level orientation film 8 and 9 is formed by the following approaches. In addition, although formation of the level orientation film 8 prepared in one substrate 1 is explained, the level orientation film 9 prepared in the substrate 2 of another side is formed similarly here.

[0020] The above-mentioned polyamic acid is expressed with the structure expression of the following [-izing 3], and this polyamic acid compounds the tetracarboxylic dianhydride expressed with the structure expression of [-izing 1], and the diamine expressed with the structure expression of [-izing 2], and is obtained.

[0021]

[Formula 1]

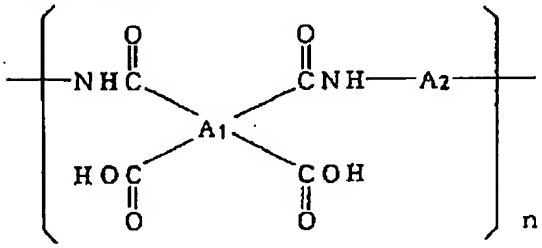


[0022]

[Formula 2]

[0023]

[Formula 3]

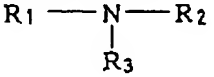


nは1以上の整数

[0024] Moreover, the above-mentioned long-chain alkylamine is for giving hydrophobicity to polyamic acid with a hydrophilic property, and this long-chain alkylamine is expressed with the structure expression of the next [-izing 4].

[0025]

[Formula 4]



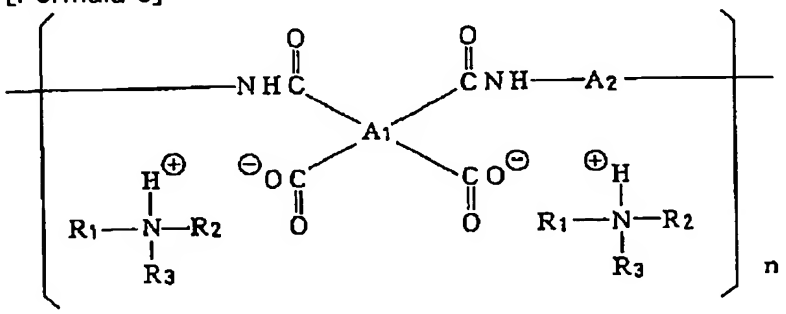
R_1 , R_2 は低級アルキル基または水素原子

R_3 は長鎖のアルキル基

[0026] The solution which melted the above-mentioned polyamic acid to the solvent, and the solution which melted the above-mentioned long-chain alkylamine to the same solvent are mixed at a predetermined rate, the ionic bond reaction of polyamic acid and the long-chain alkylamine is carried out, and the solution of the polyamic acid derivative compound (polyamic acid salt) expressed with the structure expression of the following [-izing 5] is created. In addition, as a solvent of the above-mentioned polyamic acid and long-chain alkylamine, the mixed solvent which mixed NMP (N-methyl-2-pyrrolidinone) and benzene at a rate of 1:1 is used.

[0027]

[Formula 5]



[0028] and the substrate 1 top which the above-mentioned level orientation film 8 formed the transparent electrode 4, and formed the insulator layer 6 on it -- LB -- by law, the laminating of the monomolecular film of the above-mentioned polyamic acid derivative compound is carried out to a predetermined layer, and the cascade screen of this monomolecular film is processed imide-ization, and is formed. drawing 3 -- a substrate 1 top -- the monomolecular film of a polyamic acid derivative compound -- LB -- how to make it covering by law is shown. Covering of this monomolecular film is performed as follows. First, hydrophilic processing is performed to the monomolecular-film covering side (the 6th page of insulator layer) of the above-mentioned substrate 1, and this substrate 1 is made immersed at right angles to underwater [in a tank 10].

[0029] Next, the solution of the above-mentioned polyamic acid derivative compound is dropped on the water surface between the migration barrier 11 of the shape of a bar prepared in water surface height, and a substrate 1, and the monomolecular film a is developed on the water surface.

[0030] Next, moving the migration barrier 11 in the direction of a substrate with constant speed (2 mm/min), and pushing a monomolecular film a in the direction of a substrate, after moving the migration barrier 11 in the direction of a substrate, clustering the single molecule on the water surface and adjusting the surface pressure of a monomolecular film a to 1 constant pressure (25 dyn/cm), it is made to align with this, a substrate 1 is pulled up, and the monomolecular film a on the water surface is made to put on a substrate 1.

[0031] Since a part with a hydrophilic property adheres to the substrate 1 which has performed hydrophilic processing and the single molecule on the water surface can be pulled up at this time, a molecule puts a monomolecular film a on a substrate 1 in the condition of having stood in a line in the about 1 direction. The following repeats the covering process of the above-mentioned monomolecular film a, and carries out the laminating of the above-mentioned monomolecular film a to a predetermined layer on a substrate 1.

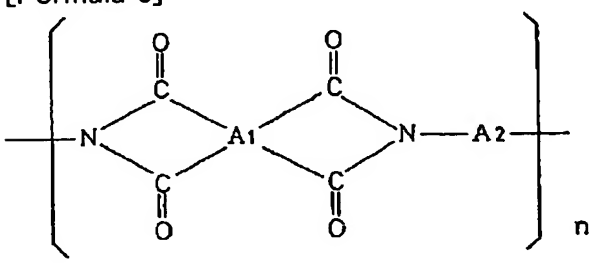
[0032] Thus, the chemical treatment by solutions, such as heat treatment heated above 200 degrees C for about 1 hour or an acid anhydride, is performed, and the cascade screen on a substrate 1 is imide-ized, and let this be the polyimide film (level orientation film 8), after carrying out the laminating of the monomolecular film a of a polyamic acid derivative compound on a substrate 1. In addition, imide-ization of this cascade screen may be performed by using together both said heat treatments and chemical treatments.

[0033] This polyimide film is what was imide-ized, and has structure like the next [-izing 6] while

polyamic acid and long-chain alkylamine remove the alkylamine of the polyamic acid derivative compound which is a compound which carried out ionic bond.

[0034]

[Formula 6]



[0035] by the way, the above LB — although the level orientation film which consists of polyimide film formed of law can make an one direction carry out orientation of the liquid crystal molecule to homogeneity as the term of [Problem(s) to be Solved by the Invention] also described, it is difficult for it to give a desired pre tilt angle to a liquid crystal molecule.

[0036] then — the liquid crystal display component of this example — both those substrates 1 and 2 — LB — the level orientation film 8 and 9 formed by law is used as the split-face film with minute irregularity, and level orientation of the liquid crystal molecule A is carried out with pre tilt angle phi according to the surface roughness of said orientation film 8 and 9.

[0037] Let these level orientation film 8 and 9 be split-face film by making into a split face the substrate side which forms this orientation film, i.e., the film surface of the insulator layers 6 and 7 which covered and formed transparent electrodes 4 and 5 in both the substrates 1 and 2.

[0038] drawing 2 being the enlarged drawing of the I section of drawing 1 , and using the transparent electrode 5 formed on the substrate 2 as the electrode which split-face-ized that front face in this example — this electrode 5 — the film surface (substrate side which forms the orientation film 9) of the wrap insulator layer 7 — a split face — carrying out — a it top — Above LB — the orientation film 9 formed by law is used as the split-face film. Thus, when the level orientation film 8 and 9 of both the substrates 1 and 2 is used as the split-face film with minute irregularity, the liquid crystal molecule A has pre tilt angle phi according to the surface roughness of the orientation film 8 and 9.

[0039] Drawing 4 shows the relation between the surface roughness (concavo-convex difference of elevation) of the above-mentioned transparent electrodes 4 and 5, and pre tilt angle phi of the liquid crystal molecule A, does not form insulator layers 6 and 7 on transparent electrodes 4 and 5, but shows the value when making the number of laminatings of a monomolecular film a at the time of carrying out the laminating of the direct monomolecular film a on an electrode into 11 layers here.

[0040] Like this drawing 4 , although pre tilt angle phi of the liquid crystal molecule A is 0 degree when the surface roughness of the above-mentioned electrodes 4 and 5 is smaller than 5nm, if the surface roughness of electrodes 4 and 5 is set to 5nm or more, after the liquid crystal molecule A has carried out the pre tilt to the 1 or 2nd page of a substrate, it will come to carry out orientation, and that pre tilt angle phi becomes large in connection with the surface roughness of electrodes 4 and 5 becoming large.

[0041] Therefore, if surface roughness of the above-mentioned electrodes 4 and 5 is set to 5nm or more and the surface roughness of the orientation film 8 and 9 is controlled in the range, orientation of pre tilt angle phi of a request of the liquid crystal molecule A can be given and carried out.

[0042] Moreover, while surface roughness becomes large so that the surface roughness of the above-mentioned electrodes 4 and 5 changes according to membrane formation thickness, such as ITO film which becomes the thickness 4 and 5 of these electrodes 4 and 5, i.e., electrodes, and thickness of electrodes 4 and 5 is thickened, field resistance of electrodes 4 and 5 becomes small. Drawing 5 shows the field resistance at the time of forming the above-mentioned electrodes 4 and 5 by the ITO film, and the relation of surface roughness.

[0043] and the above-mentioned liquid crystal display component — setting — both the substrates 1 and 2 — LB — since level orientation of the liquid crystal molecule A is carried out with pre tilt angle

phi according to the surface roughness of said orientation film 8 and 9 by using as the split-face film with minute irregularity the level orientation film 8 and 9 formed by law, good display quality without the poor initial orientation of liquid crystal, the reverse tilt discreenation at the time of driver voltage impression, etc. can be acquired.

[0044] In addition, although the front face of the transparent electrodes 4 and 5 under it is split-face-ized in the above-mentioned example in order to make into a split face the film surface of the insulator layers 6 and 7 which are the substrate sides which form the orientation film 8 and 9, the film surface of said insulator layers 6 and 7 may be good also as a split face by split-face-ized etching, and the front face of electrodes 4 and 5 may not be a split face in that case.

[0045] moreover, the liquid crystal display component of the above-mentioned example -- transparent electrodes 4 and 5 -- insulator layers 6 and 7 -- covering -- a it top -- LB, although the level orientation film 8 and 9 is formed by law This invention is a thing applicable also to the liquid crystal display component which forms the level orientation film 8 and 9 by the direct LB method on transparent electrodes 4 and 5. In that case What is necessary is to split-face-ize the front face of the transparent electrodes 4 and 5 which are the substrate sides which form the orientation film 8 and 9 like the above-mentioned example, and just to let the orientation film 8 and 9 be split-face film.

[0046] Furthermore, in the above-mentioned example, although the polyamic acid derivative compound to which make polyamic acid and long-chain alkylamine come to react as an amphiphilic compound which has a hydrophobic radical and a hydrophilic radical was used, the amphiphilic compound to be used will not be restricted to said polyamic acid derivative compound, if it becomes polyimide by imide-ized processing.

[0047] Moreover, although the liquid crystal display component of the above-mentioned example is the thing in TN mode or STN mode, this invention is applicable to the liquid crystal display component of the level orientation mold of the ECB (electric-field control mold birefringence) modes, the liquid crystal display component which used a ferroelectric liquid crystal or antiferroelectricity liquid crystal.

[0048]

[Effect of the Invention] since the liquid crystal display component of this invention uses the level orientation film as the split-face film with minute irregularity and level orientation of the liquid crystal molecule is carried out with the pre tilt angle according to the surface roughness of said orientation film -- LB -- forming the level orientation film by law, orientation of the pre tilt angle of a request of a liquid crystal molecule can be given and carried out, and good display quality without the poor initial orientation of liquid crystal, the reverse tilt discreenation at the time of driver voltage impression, etc. can be acquired.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The enlarged drawing of the I section of drawing 2 .
[Drawing 2] The sectional view of a liquid crystal display component showing one example of this invention.
[Drawing 3] Drawing showing the laminated layers method of the monomolecular film to the substrate top by the LB method.
[Drawing 4] Drawing showing the relation between the surface roughness of an electrode, and the pre tilt angle of a liquid crystal molecule.
[Drawing 5] Drawing showing field resistance of an electrode, and the relation of surface roughness.
[Description of Notations]
1 2 — Substrate
4 5 — Electrode
6 7 — Insulator layer
8 9 — Level orientation film formed by the LB method
A — Liquid crystal molecule
phi — Pre tilt angle of a liquid crystal molecule

[Translation done.]

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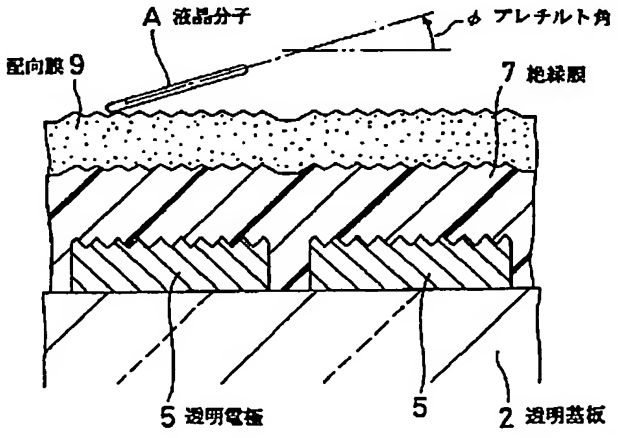
(54)【発明の名称】液晶表示素子

(57)【要約】
【目的】ＬＢ法により水平配向膜を形成したものでありながら、液晶分子を所望のプレチルト角をもたせて配向させて、液晶の初期配向不良や駆動電圧印加時のリバースチルトディスクリネーション等がない良好な表示品質を得ることができる液晶表示素子を提供する。
【構成】ＬＢ法により形成した水平配向膜９を微小な凹凸をもつ粗面膜とし、液晶分子Ａを前記配向膜９の表面粗さに応じたプレチルト角φをもって水平配向させた。



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【特許請求の範囲】

【請求項１】液晶層をはさんで対向する一対の透明基板の互いに対向する面に、透明電極と、ラングミュア・ブロジェット法により疎水性基と親水性基を有する両親媒性化合物の単分子膜を積層してこの積層膜をイミド化処理したポリイミド膜からなる水平配向膜とを形成した液晶表示素子であって、

前記水平配向膜を微小な凹凸をもつ粗面膜とし、液晶分子を前記配向膜の表面粗さに応じたプレチルト角をもって水平配向させたことを特徴とする液晶表示素子。

【請求項２】前記水平配向膜は、この配向膜を形成する下地面を粗面とすることによって粗面膜とされていることを特徴とする請求項１に記載の液晶表示素子。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、液晶分子を水平方向に配向させた液晶表示素子に関するものである。

【０００２】

【従来の技術】液晶分子を水平方向に配向させた液晶表示素子には、ＴＮ（ツイステッド・ネマティック）モードのもの、ＳＴＮ（スーパー・ツイステッド・ネマティック）モードのもの、ＥＣＢ（電界制御型複屈折）モードのうちの水平配向型のもの、強誘電性液晶または反強誘電性液晶を用いたもの等がある。

【０００３】これらの液晶表示素子は、液晶層をはさんで対向する一対の透明基板の互いに対向する面に、透明電極と、液晶分子を水平方向に配向させるための水平配向膜とを形成した構成となっている。

【０００４】これらの液晶素子の基板上に設けられる水平配向膜は、従来、基板上にポリイミド等を塗布してその膜面をラビング処理する方法、または基板上に酸化硅素（SiO_2）等を斜方蒸着する方法によって形成されていたが、最近では、ラングミュア・ブロジェット（Langumuir-Blodgett）法によってポリイミド膜からなる水平配向膜を形成する方法が採用されるようになってきている。

【０００５】上記ラングミュア・ブロジェット法（以下、ＬＢ法と記す）は、静水面上に単分子膜を作り、あらかじめ水中に垂直に浸漬させておいた基板を一定速度で引上げながら、水面上の単分子膜を基板上に被着させて行く方法である。

【０００６】このＬＢ法によるポリイミド膜の形成は、疎水性基と親水性基を有する両親媒性化合物、例えばポリアミック酸と長鎖アルキル基を有するアミンとをイオン結合反応させてなるポリアミック酸誘導体化合物の単分子膜をＬＢ法により基板上に被着させる工程を複数回繰返して前記単分子膜を基板上に積層し、この積層膜をイミド化処理してポリイミド膜とする方法で行なわれている。

【０００７】上記ＬＢ法によって基板上に被着された両親媒性化合物の単分子膜は、分子長の長い分子が基板の引上げ方向に沿って並んでいるため、この単分子膜の積層膜をイミド化したポリイミド膜は、液晶分子を一方向に均一に配向させる配向性をもっており、したがって、その膜面をラビング処理することなく、このポリイミド膜をそのまま水平配向膜とすることができる。

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【０００８】ところで、液晶表示素子においては、液晶分子の配向状態が液晶表示素子の電気光学特性に大きく影響するため、良好な表示を得るには、液晶分子の配向の安定性を良くしてやる必要がある。

【０００９】この液晶分子の配向の安定性を左右する重要な要素は、電圧を印加しない状態下での基板面に対する液晶分子のプレチルト角（液晶分子の長軸が基板面に対してなす角度）であり、このプレチルト角が大きいほど、液晶分子の配向の安定性が良くなる。

【００１０】

【発明が解決しようとする課題】しかしながら、上記ＬＢ法によって形成された水平配向膜による場合、液晶分子を一方向に均一に配向させることはできるが、液晶分子に所望のプレチルト角をもたせることが困難であった。

【００１１】このため、水平配向膜を上記ＬＢ法によって形成している従来の液晶表示素子は、液晶の初期配向不良を生じたり、駆動電圧印加時にリバースチルトディスクリネーションを発生したりするという問題をもっていた。

【００１２】本発明は、ＬＢ法により水平配向膜を形成したものでありながら、液晶分子を所望のプレチルト角をもたせて配向させて、液晶の初期配向不良や駆動電圧印加時のリバースチルトディスクリネーション等がない良好な表示品質を得ることができる液晶表示素子を提供することを目的としたものである。

【００１３】

【課題を解決するための手段】本発明の液晶表示素子は、液晶層をはさんで対向する一対の透明基板の互いに対向する面に、透明電極と、ＬＢ法により疎水性基と親水性基を有する両親媒性化合物の単分子膜を積層してこの積層膜をイミド化処理したポリイミド膜からなる水平配向膜とを形成したものであって、前記水平配向膜を微小な凹凸をもつ粗面膜とし、液晶分子を前記配向膜の表面粗さに応じたプレチルト角をもって水平配向させたことを特徴とするものである。本発明の一実施態様では、前記水平配向膜を、この配向膜を形成する下地面を粗面とすることによって粗面膜としている。

【００１４】

【作用】このように、水平配向膜を微小な凹凸をもつ粗面膜とすると、液晶分子が配向膜の表面粗さに応じたプレチルト角をもって水平配向するため、この配向膜の表面粗さを制御すれば、液晶分子を所望のプレチルト角をもたせて配向させて、液晶の初期配向不良や駆動電圧印

加時のリバースチルトディスクリネーション等がない良好な表示品質を得ることができる。

【００１５】

【実施例】以下、本発明の実施例を図面を参照して説明する。

【００１６】図２は液晶表示素子の断面図である。この液晶表示素子は、ガラス等からなる一対の透明基板１，２を枠状のシール材３を介して接合し、この両基板１，２間のシール材３で囲まれた領域に液晶を封入したもので、両基板１，２の互いに対向する面にはそれぞれ、ＩＴＯ等の透明導電膜からなる透明電極４，５が形成されている。また、この両基板１，２の電極形成面は、酸化硅素（SiO_2）等からなる透明な絶縁膜６，７で覆われており、この絶縁膜６，７の上に水平配向膜８，９が形成されている。

【００１７】なお、この液晶表示素子は、ＴＮモードまたはＳＴＮモードのものであり、両基板１，２間に封入された液晶の分子Ａは、両基板１，２側の配向膜８，９の近傍の液晶分子Ａの各配向方向を前記配向膜８，９で規制され、両基板１，２間において所定のツイスト角でツイスト配向している。ただし、図２では、便宜上、液晶分子Ａをツイスト配向していない状態で示している。

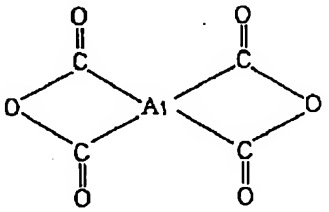
【００１８】上記水平配向膜８，９は、いずれも、疎水性基と親水性基を有する両親媒性化合物、例えば、ポリアミック酸と長鎖アルキル基を有するアミン（以下、長鎖アルキルアミンという）とを反応させてなる化合物の単分子膜を数層～数十層に重ねて被着させた膜をイミド化したポリイミド膜からなっている。

【００１９】この水平配向膜８，９は、次のような方法で形成する。なお、ここでは、一方の基板１に設ける水平配向膜８の形成について説明するが、他方の基板２に設ける水平配向膜９も同様にして形成する。

【００２０】上記ポリアミック酸は、下記の［化３］の構造式で表わされ、このポリアミック酸は、［化１］の構造式で表わされるテトラカルボン酸二無水物と、［化２］の構造式で表わされるジアミンとを合成して得られる。

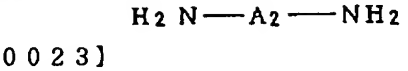
【００２１】

【化１】



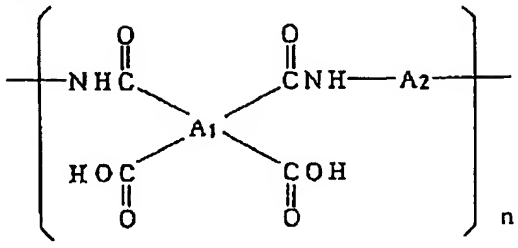
【００２２】

【化２】



【００２３】

【化３】

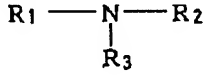


nは１以上の整数

【００２４】また、上記長鎖アルキルアミンは、親水性をもつポリアミック酸に疎水性を付与するためのものであり、この長鎖アルキルアミンは次の［化４］の構造式で表わされる。

【００２５】

【化４】



R_1，R_2 は低級アルキル基または水素原子

R_3 は長鎖のアルキル基

【００２６】上記ポリアミック酸を溶媒に溶かした溶液と、上記長鎖アルキルアミンを同じ溶媒に溶かした溶液とを所定の割合で混合し、ポリアミック酸と長鎖アルキルアミンとをイオン結合反応させて、下記の［化５］の構造式で表わされるポリアミック酸誘導体化合物（ポリアミック酸塩）の溶液を作成する。なお、上記ポリアミック酸および長鎖アルキルアミンの溶媒としては、ＮＭＰ（Ｎ－メチル－２－ピロリジノン）とベンゼンを１：１の割合で混合した混合溶媒を用いる。

【００２７】

【化５】

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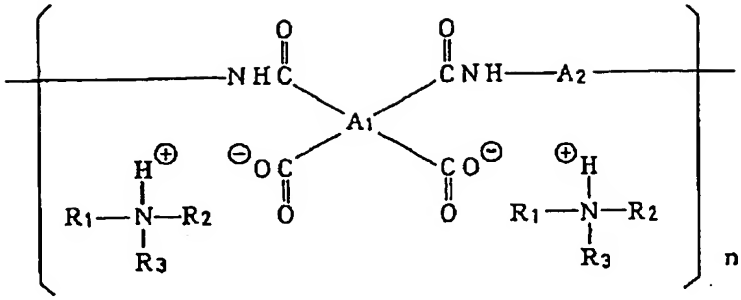


【００２８】そして、上記水平配向膜８は、透明電極４を形成しその上に絶縁膜６を形成した基板１上に、ＬＢ法によって上記ポリアミック酸誘導体化合物の単分子膜を所定層に積層し、この単分子膜の積層膜をイミド化処理して形成する。図３は、基板１上にポリアミック酸誘導体化合物の単分子膜をＬＢ法によって被着させる方法を示している。この単分子膜の被着は次のようにして行なう。まず、上記基板１の単分子膜被着面（絶縁膜６面）に親水性処理を施し、この基板１を水槽１０内の水中に垂直に浸漬させる。

【００２９】次に、水面高さに設けたバー状の移動バリア１１と基板１との間の水面上に上記ポリアミック酸誘導体化合物の溶液を滴下して、その単分子膜ａを水面上に展開させる。

【００３０】次に、移動バリア１１を基板方向に移動させて水面上の単分子を密集させ、単分子膜ａの表面圧を一定圧（２５dyn/cm）に調整した後、移動バリア１１を基板方向に一定速度（２mm/min）で移動させて単分子膜ａを基板方向に押しながら、これに同調させて基板１を引上げて、水面上の単分子膜ａを基板１上に被着させる。

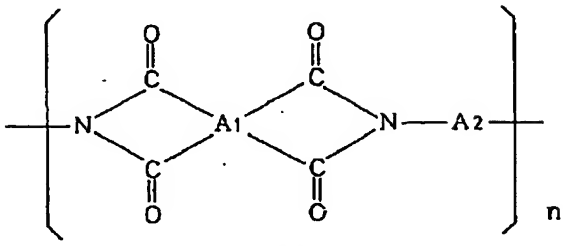
【００３１】このとき、水面上の単分子は、親水性をもつ部分が親水性処理を施してある基板１に付着して引上げられるため、単分子膜ａは、分子がほぼ一方向に並んだ状態で基板１上に被着する。以下は、上記単分子膜ａの被着工程を繰返して、基板１上に上記単分子膜ａを所定層に積層する。

【００３２】このようにして基板１上にポリアミック酸誘導体化合物の単分子膜ａを積層した後は、２００℃以上で約１時間加熱する熱処理、あるいは、酸無水物等の溶液による化学処理を行なって、基板１上の積層膜をイミド化し、これをポリイミド膜（水平配向膜８）とする。なお、この積層膜のイミド化は前記熱処理と化学処理との両方を併用して行なってもよい。

【００３３】このポリイミド膜は、ポリアミック酸と長鎖アルキルアミンとがイオン結合した化合物であるポリアミック酸誘導体化合物のアルキルアミンを除去するとともに、イミド化したもので、次の［化６］のような構造をもっている。

【００３４】

【化６】



【００３５】ところで、上記ＬＢ法によって形成されたポリイミド膜からなる水平配向膜は、［発明が解決しようとする課題］の項でも述べたように、液晶分子を一方向に均一に配向させることはできるが、液晶分子に所望のプレチルト角をもたせることが難しい。

【００３６】そこで、この実施例の液晶表示素子では、その両基板１，２にＬＢ法によって形成する水平配向膜８，９を微小な凹凸をもつ粗面膜とし、液晶分子Ａを前記配向膜８，９の表面粗さに応じたプレチルト角φをもって水平配向させている。

【００３７】この水平配向膜８，９は、この配向膜を形成する下地面、つまり両基板１，２に透明電極４，５を覆って形成した絶縁膜６，７の膜面を粗面とすることによって粗面膜とされている。

【００３８】図２は図１のＩ部の拡大図であり、この実施例では、基板２上に形成した透明電極５をその表面を粗面化した電極とすることにより、この電極５を覆う絶縁膜７の膜面（配向膜９を形成する下地面）を粗面にし、その上に上記ＬＢ法によって形成する配向膜９を粗面膜としている。このように、両基板１，２の水平配向膜８，９を微小な凹凸をもつ粗面膜とすると、液晶分子Ａが配向膜８，９の表面粗さに応じたプレチルト角φをもつ。

【００３９】図４は上記透明電極４，５の表面粗さ（凹凸の高低差）と液晶分子Ａのプレチルト角φとの関係を示しており、ここでは、透明電極４，５の上に絶縁膜６，７を設けず、電極上に直接単分子膜ａを積層した場合の、単分子膜ａの積層数を１１層としたときの値を示している。

【００４０】この図４のように、上記電極４，５の表面粗さが５ｎｍより小さいと、液晶分子Ａのプレチルト角φは０°であるが、電極４，５の表面粗さが５ｎｍ以上になると液晶分子Ａが基板１，２面に対しプレチルトした状態で配向するようになり、そのプレチルト角φは、

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電極４，５の表面粗さが大きくなるのにともなって大きくなる。

【００４１】したがって、上記電極４，５の表面粗さを５ｎｍ以上にし、その範囲で配向膜８，９の表面粗さを制御すれば、液晶分子Ａを所望のプレチルト角φをもたせて配向させることができる。

【００４２】また、上記電極４，５の表面粗さは、この電極４，５の膜厚、つまり電極４，５となるＩＴＯ膜等の成膜厚さに応じて変化し、電極４，５の膜厚を厚くするほど、表面粗さが大きくなるとともに、電極４，５の面抵抗が小さくなる。図５は上記電極４，５をＩＴＯ膜で形成した場合の面抵抗と表面粗さの関係を示している。

【００４３】そして、上記液晶表示素子においては、その両基板１，２にＬＢ法によって形成する水平配向膜８，９を微小な凹凸をもつ粗面膜とすることにより、液晶分子Ａを前記配向膜８，９の表面粗さに応じたプレチルト角φをもって水平配向させているため、液晶の初期配向不良や駆動電圧印加時のリバースチルトディスクリネーション等がない良好な表示品質を得ることができる。

【００４４】なお、上記実施例では、配向膜８，９を形成する下地面である絶縁膜６，７の膜面を粗面とするために、その下の透明電極４，５の表面を粗面化しているが、前記絶縁膜６，７の膜面は粗面化エッチングによって粗面としてもよく、その場合は、電極４，５の表面は粗面でなくてもよい。

【００４５】また、上記実施例の液晶表示素子は、透明電極４，５を絶縁膜６，７で覆ってその上にＬＢ法により水平配向膜８，９を形成したものであるが、本発明は、透明電極４，５の上に直接ＬＢ法によって水平配向膜８，９を形成している液晶表示素子にも適用できるもので、その場合は、配向膜８，９を形成する下地面である透明電極４，５の表面を上記実施例のように粗面化して、配向膜８，９を粗面膜とすればよい。

【００４６】さらに上記実施例では、疎水性基と親水性基を有する両親媒性化合物として、ポリアミック酸と長鎖アルキルアミンとを反応させてなるポリアミック酸誘導体化合物を用いたが、使用する両親媒性化合物は、イミド化処理によりポリイミドとなるものであれば、前記ポリアミック酸誘導体化合物に限らない。

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【００４７】また、上記実施例の液晶表示素子は、ＴＮモードまたはＳＴＮモードのものであるが、本発明は、ＥＣＢ（電界制御型複屈折）モードのうちの水平配向型の液晶表示素子や、強誘電性液晶または反強誘電性液晶を用いた液晶表示素子等にも適用することができる。

【００４８】

【発明の効果】本発明の液晶表示素子は、水平配向膜を微小な凹凸をもつ粗面膜とし、液晶分子を前記配向膜の表面粗さに応じたプレチルト角をもって水平配向させたものであるから、ＬＢ法により水平配向膜を形成したものでありながら、液晶分子を所望のプレチルト角をもたせて配向させて、液晶の初期配向不良や駆動電圧印加時のリバースチルトディスクリネーション等がない良好な表示品質を得ることができる。

【図面の簡単な説明】

【図１】図２のＩ部の拡大図。

【図２】本発明の一実施例を示す液晶表示素子の断面図。

【図３】ＬＢ法による基板上への単分子膜の積層法を示す図。

【図４】電極の表面粗さと液晶分子のプレチルト角との関係を示す図。

【図５】電極の面抵抗と表面粗さの関係を示す図。

【符号の説明】

１，２…基板

４，５…電極

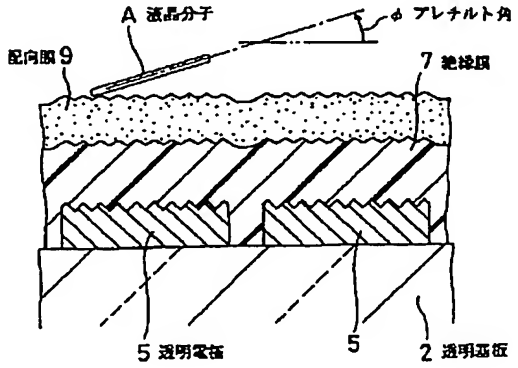
６，７…絶縁膜

８，９…ＬＢ法により形成した水平配向膜

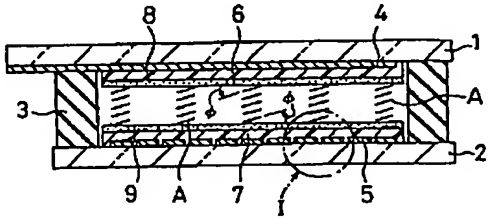
Ａ…液晶分子

φ…液晶分子のプレチルト角

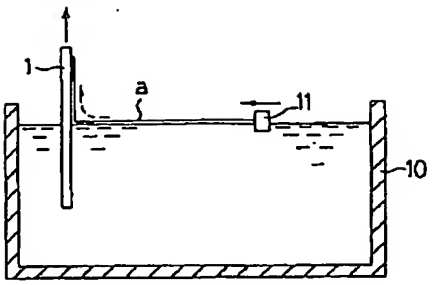
【図１】



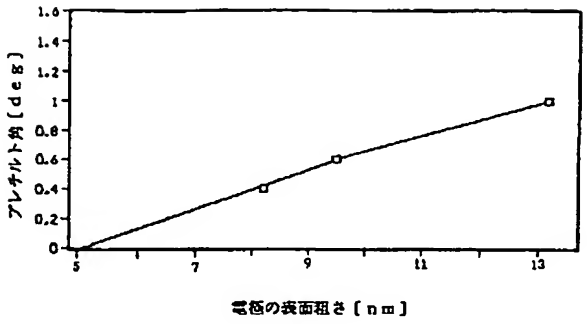
【図２】



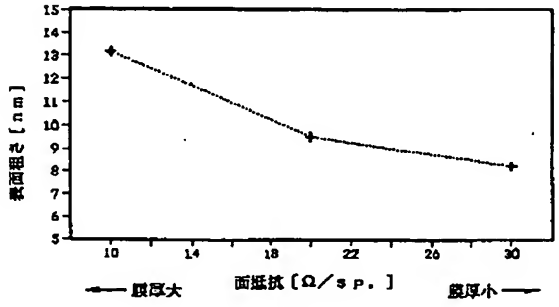
【図３】


1
a
11
10

【図４】


アレチルト角［deg］
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
5
7
9
11
13
電極の表面粗さ［nm］

【図５】


表面粗さ［nm］
15
14
13
12
11
10
9
8
7
6
5
10
14
18
22
26
30
膜厚大
面抵抗［Ω／sp.］
膜厚小